



AFTON PASSIVE HOUSE

CASE STUDY

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying 1.5 hours of credit toward Building Officials and Residential Contractors code /1 hour energy continuing education requirements.”

For additional continuing education approvals, please see your credit tracking card.

Project Team

- General Contractor
 - Bluff City Builders – Jay Roettger
- Architectural Firm
 - CR-BPS, Inc – Nancy Schultz, AIA
- Architect of Record
 - Building Foundry – Sam Bontrager, AIA
- Client
 - Afton Passive House - Barbara & Michael Morehead
- PHIUS Rater
 - DPIS Builder Services Energy Department – Eric Boyd



Discussion Points

01

Designing
Early with
Modeling
Software

15 minutes

02

Brief project
description –
Owner's Goals

25 minutes

03

Wicking of
Moisture
through
Concrete

25 minutes

04

Looking at
some Final
Numbers

5 minutes

01

Designing Early with Modeling Software



PASSIVE HOUSE - WHAT DOES IT MEAN

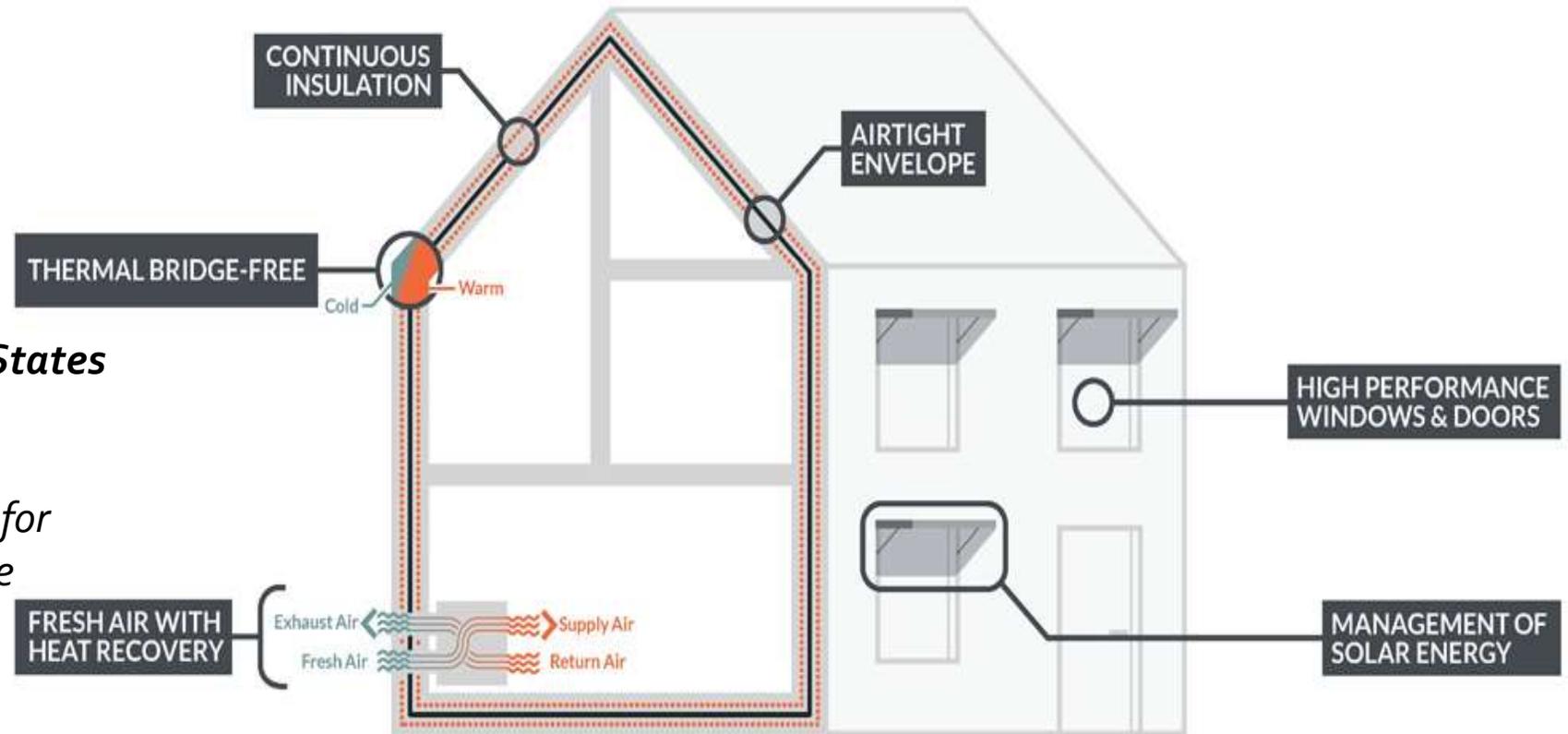
- *Superinsulation*
- *Airtight Envelope*
- *Energy Recovery Ventilation*
- *High Performance Windows*
- *Manage Solar Gain*
- *Manage Thermal Bridging*

- ***Passivhaus Institute (PHI)***
Germany - 1996
- ***Passive House Institute United States***
US - 2007

- *2015 - Single performance metric for all climate zones was not workable*

BENEFITS

- *Cut carbon emissions*
- *Reduce energy consumption*
- *Provides superb comfort*
- *Great indoor air quality*



Hammer & Hand, 2018

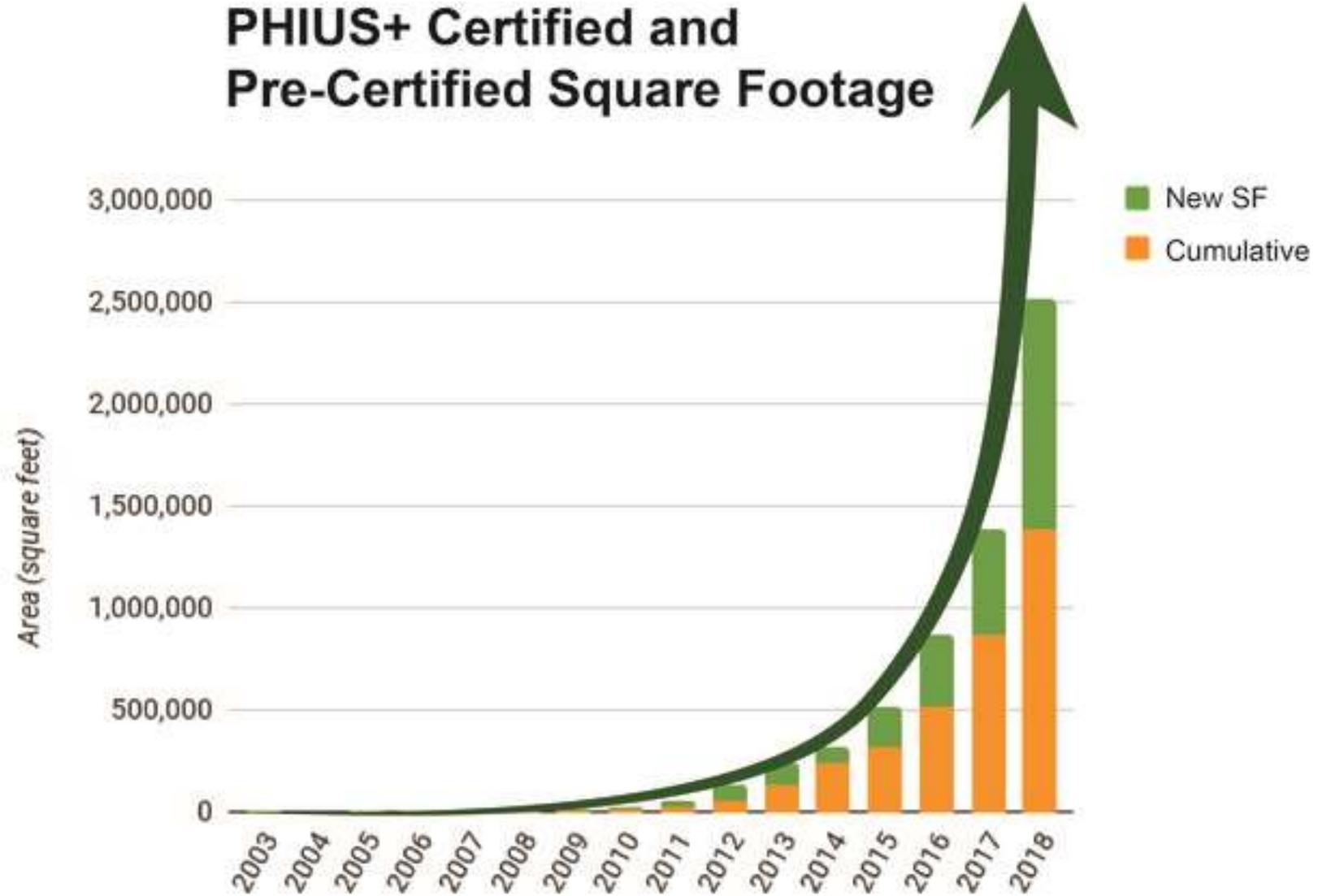


Passive House Institute US

PHIUS + 2015
Passive Building Standards

PHIUS + 2018
Passive Building Standards

PHIUS+ Certified and Pre-Certified Square Footage



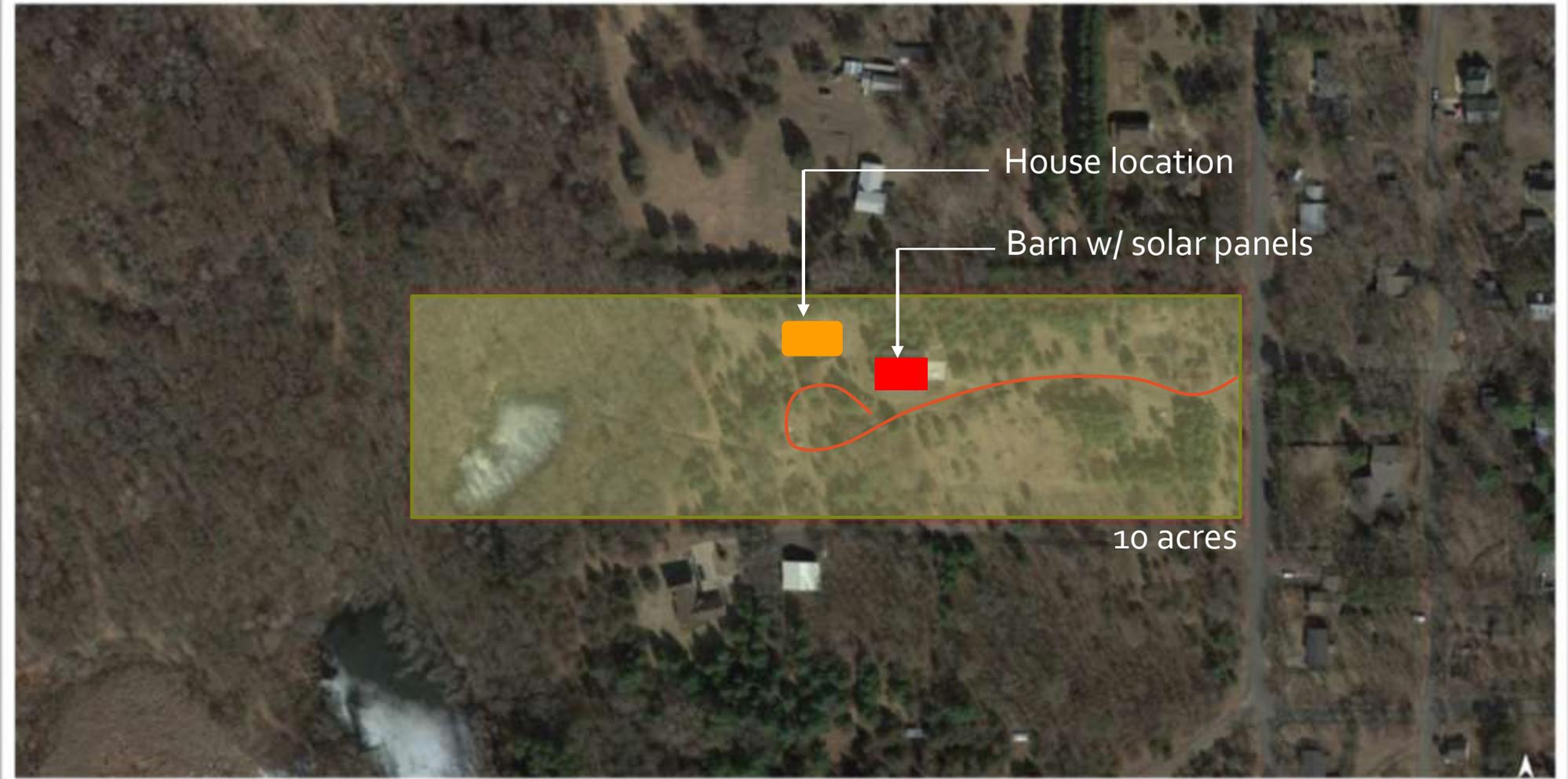


Project Location





10 acres





south elevation



east elevation

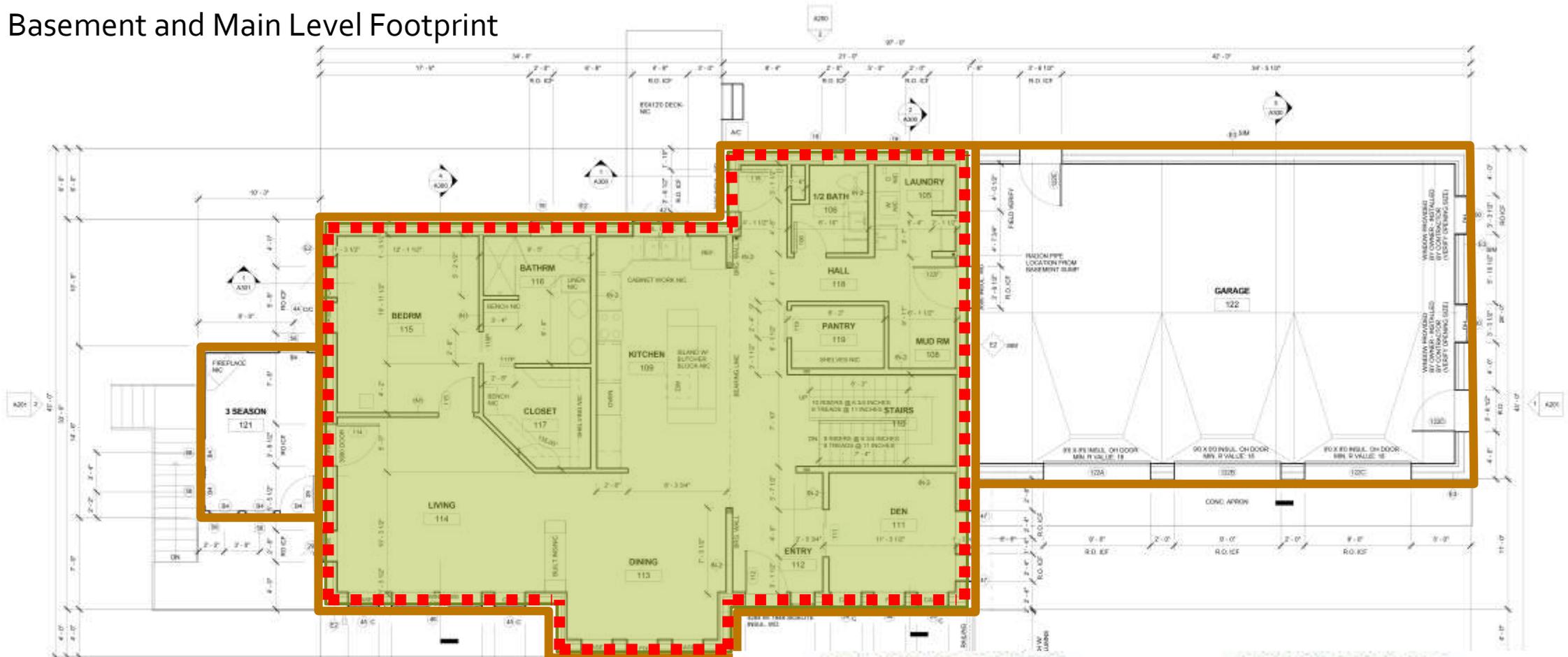


southwest view



north elevation

Basement and Main Level Footprint



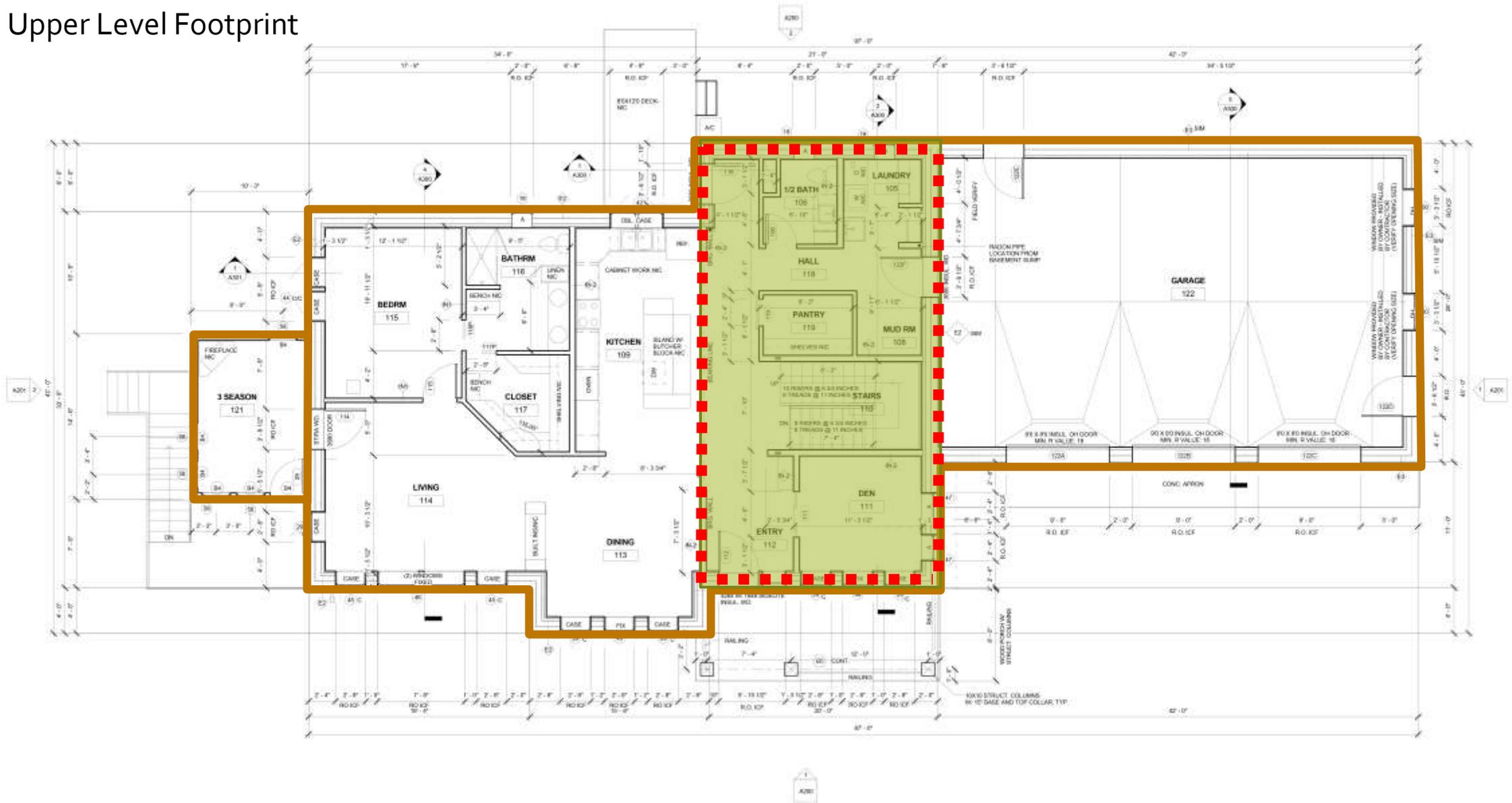
GROSS SQUARE FOOTAGE

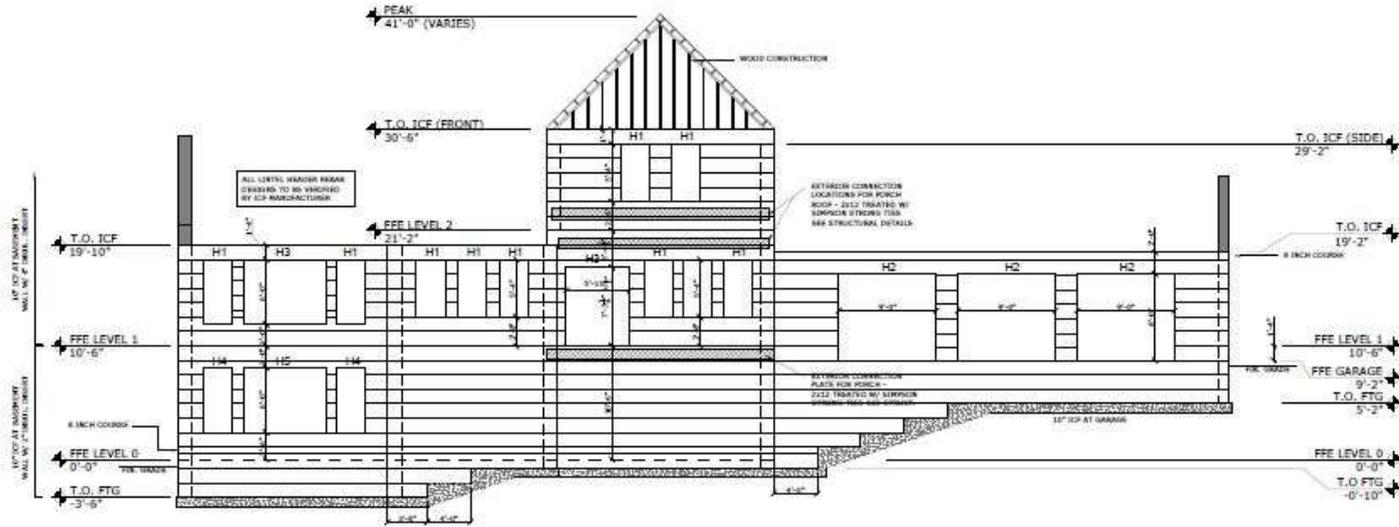
LEVEL 0 (BASEMENT)	2033 SF
LEVEL 1 (MAIN)	2033 SF
LEVEL 2 (UPPER)	819 SF
TOTAL GROSS	4885 SF
GARAGE	1176 SF
3 SEASON PORCH	147 SF

NET SQUARE FOOTAGE

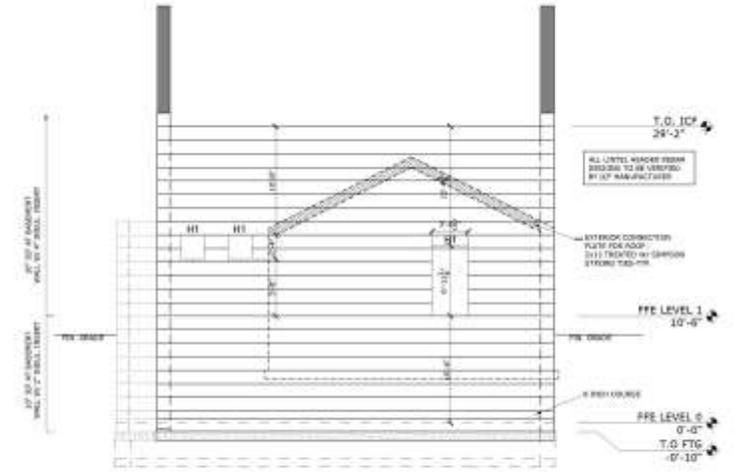
LEVEL 0 (BASEMENT)	1697 SF
LEVEL 1 (MAIN)	1697 SF
LEVEL 2 (UPPER)	648 SF
TOTAL NET	4042 SF

Upper Level Footprint

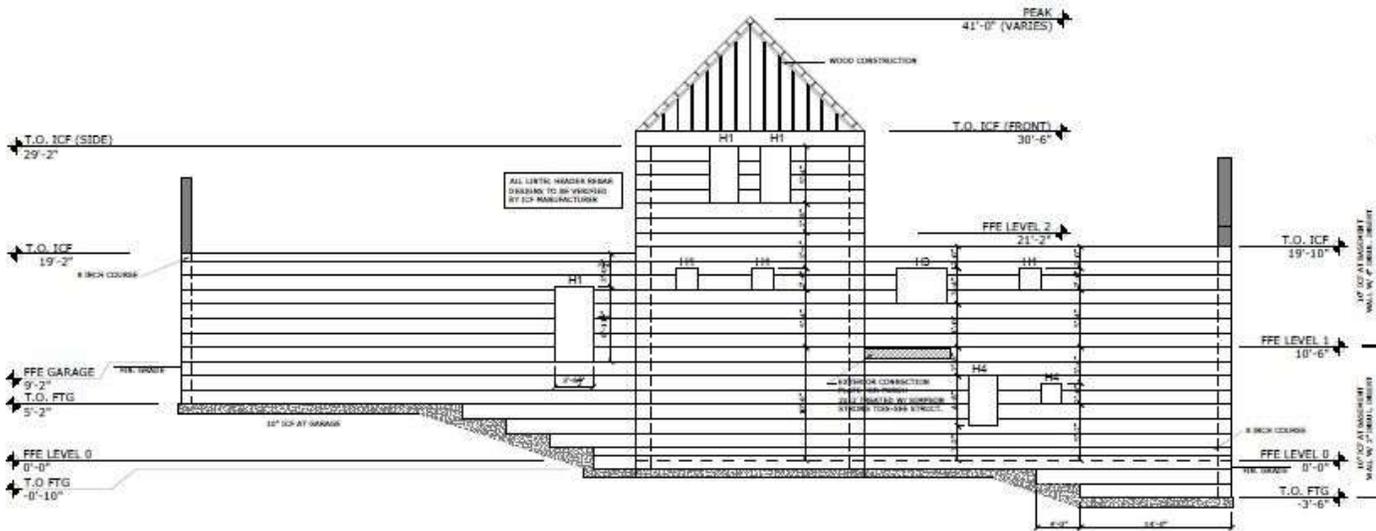




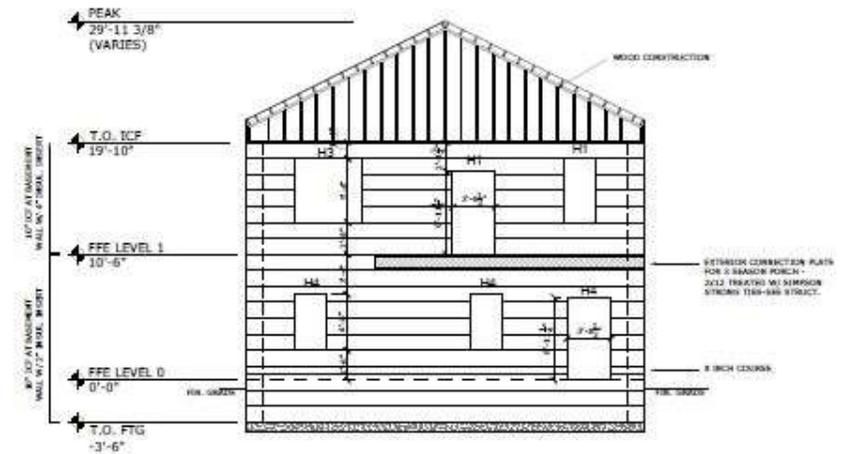
1 SOUTH ICF ELEVATION
1/8" = 1'-0"



6 EAST ICF ELEVATION PART 2 AT HOUSE
1/8" = 1'-0"



2 NORTH ICF ELEVATION
1/8" = 1'-0"



4 WEST ICF ELEVATION PART 2
1/8" = 1'-0"



Welcome to:

eQUEST

Quick Energy Simulation Tool



WUFI®





Free Basic Versions





south elevation



east elevation



southwest view



north elevation



WUFI®





File Input Options Database Help

Passive house verification English/IP/Outer dimensions Assign data Project

Component 9: Basement Wall East 1
 Component 10: Basement Wall North 1
 Component 11: Basement Wall North 2
 Component 12: Basement Wall West 2
 Component 13: Basement Wall West 1
 Component 14: Basement Wall West 3
 Component 15: Basement Wall East 2
 Component 16: Door East to Garage - ED004
 Component 17: Door North Pabo - ED007
 Component 18: Door to Patio - ED002
 Component 19: Door West Basement - ED003
 Component 20: Door South Front - ED001
 Component 21: Window South Front Door Lite
 Component 22: Exterior Wall Double Stud/Second Level
 Component 23: Window South LL 4
 Component 24: Window South UL 2
 Component 25: Window South ML 1
 Component 26: Window South ML 2
 Component 27: Window South ML 3
 Component 28: Window South ML 5
 Component 29: Window South ML Den 1
 Component 30: Window South ML Den 3
 Component 31: Window South UL 1
 Component 32: Window South LL 1
 Component 33: Window South ML Den 2
 Component 34: Window South LR 2A
 Component 35: Window South LR 2B
 Component 36: Window South LL 2
 Component 37: Window South LL 3
 Component 38: Window South ML 4
 Component 39: Window North UP 1
 Component 40: Window West LR
 Component 41: Window West BR 5
 Component 42: Window West BR 2
 Component 43: Window West BR 1
 Component 44: Window West BR 3
 Component 45: Window North Kitchen 2
 Component 46: Window North Kitchen 1
 Component 47: Window North Basement 1
 Component 48: Window North UP 2
 Component 49: Window Den East 1
 Component 50: Window North Bathroom
 Component 51: Window North Basement 2

Data Picture

Project data

Client

Surname & Name Mike and Barbara Morehead
 Locality St. Paul, MN
 Postal code 55106
 Street 1699 Sims Ave
 Tel.
 e-mail

Building

Name/Type Aflon Passive House
 Year of construction 2016
 Locality Aflon, Minnesota
 Postal code 55001
 Street 1540 Quant Ave S
 Country United States

Owner

Owner = Client

Surname & Name Mike and Barbara Morehead
 Locality St. Paul, MN
 Postal code 55106
 Street 1699 Sims Ave

Responsible person

Surname & Name Sam Bontrager, Samuel Bontrager LLC, Mike Lebeau, CR-EPS, Inc.
 Locality Minneapolis, MN
 Postal code 55417
 Street 2809 E Minnehaha Parkway 104
 Tel. 612-554-2085
 e-mail sam.bontrager@yahoo.com

Data state/results Show warnings

Heating demand: 5.7 kBtu/ft²yr

Cooling demand: 0.62 kBtu/ft²yr

Heating load: 4.78 Btu/hr ft²

Cooling load: 1.3 Btu/hr ft²

Primary energy: 5735 kWh/Person yr

Site energy: 6.85 kBtu/ft²yr

Metric	Value	Status
Heating demand	5.7 kBtu/ft ² yr	Pass
Cooling demand	0.62 kBtu/ft ² yr	Pass
Heating load	4.78 Btu/hr ft ²	Pass
Cooling load	1.3 Btu/hr ft ²	Pass
Primary energy	5735 kWh/Person yr	Pass
Site energy	6.85 kBtu/ft ² yr	Pass



CLIMATE DATA MAP

WUFI Targets for Climate Zone 6:

Annual Heating Demand: **6.9 kBtu/ft²yr**

Annual Cooling Demand: **3.1 kBtu/ft²yr**

Peak Heating Load: **5.6 Btu/hr ft²**

Peak Cooling Load: **4.3 Btu/hr ft²**

Primary Energy: **6200 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**



WUFI® Passive V.3.0.1.0 G:\0_Business LLC\3_Projects\18-010 Morehead Passive Docs\Current Information for Certification\WUFI\Morehead Round 3 Changes 10_31_2018_81 ACH50.mwp

File Input Options Database Help

Scope: **Passive house verification** English/JP/Outer dimensions Assign data

Building
 PH case: Passive house: Residential
 Zone 1
 Visualized components
 Component 1: Basement Wall Underground
 Component 2: Exterior Wall Main/Second Level
 Component 3: Rat Ceiling
 Component 4: Sloped Ceiling Areas
 Component 5: Basement Slab
 Component 6: Basement Wall South 1
 Component 7: Basement Wall South 2
 Component 8: Basement Wall south 3
 Component 9: Basement Wall East 1
 Component 10: Basement Wall North 1
 Component 11: Basement Wall North 2
 Component 12: Basement Wall West 2
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 Component 28: Window South ML 5
 Component 29: Window South ML Den 1
 Component 30: Window South ML Den 3
 Component 31: Window South UL 1
 Component 32: Window South LL 1

General Assembly Surface

Assigned assembly

Name	R [hr ft² F/Btu]
Ver 2 - Substructure - Wall_Exterior_ICF	53.851

Available assemblies

Name	R [hr ft² F/Btu]
B10 - Superstructure - Roof_Wd Deck_Joocy_EPDM_R 88_HUBBA	89.28
A - Substructure - Wall_Foundation_HUBBA_B	37.323
A - Substructure - Floor_Insulated Concrete_HUBBA	57.363
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45
B2010 - Ext Wall_Dble Stud_Spray Foam_HUBBA_C_ R 55	55.45

Inhomogenous layers

Thermal resistance: 53.851 / 54.324 hr ft² F/Btu (EN ISO 6946 / homogenous layer)

Heattransfer coefficient (U-value): 0.02 Btu/hr ft² F

Thickness: 19.582 in

Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb °F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Steel lap siding	19.98	0.45	8.3333	0.492	
2	Air Layer 20 mm	0.00	0.24	0.0751	0.787	
3	Spun Bonded Polyolefin Membrane (SBP)	27.97	0.36	1.3867	0.022	
4	Plywood (USA)	29.34	0.45	0.0485	0.75	

Data state/results Show warnings

Heating demand: 5.7 kBtu/ft²yr

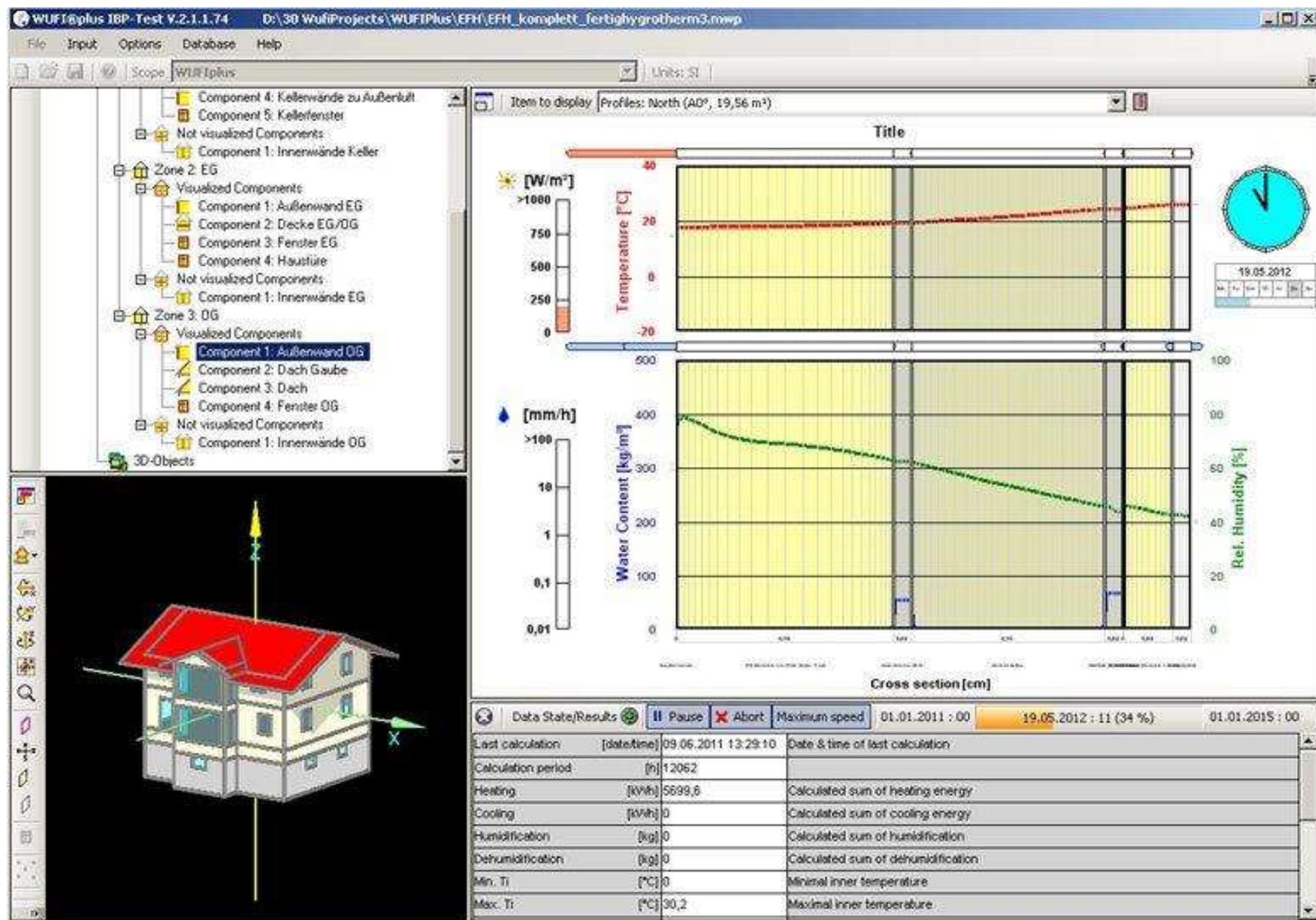
Cooling demand: 0.62 kBtu/ft²yr

Heating load: 4.78 Btu/hr ft²

Cooling load: 1.3 Btu/hr ft²

Primary energy: 5735 kWh/Person yr

Site energy: 6.85 kBtu/ft²yr



BUILDING INFORMATION

Category:	Residential
Status:	Completed
Building type:	New construction
Year of construction:	2016
Units:	1
Number of occupants:	5 (Design)


Boundary conditions

Climate:	MINNEAPOLIS-ST PAUL INT ARP MN
Internal heat gains:	0.7 Btu/hr ft ²
Interior temperature:	68 °F
Overheat temperature:	77 °F

Building geometry

Enclosed volume:	51441.3 ft ³
Total area envelope:	9272.4 ft ²
AV ratio:	0.2 1/ft
Floor area:	4027 ft ²

PASSIVEHOUSE REQUIREMENTS
Certificate criteria: PHIUS+ 2015 Standard

Heating demand

specific:	4.97 kBtu/ft ² yr
target:	6.9 kBtu/ft ² yr
total:	20022.48 kBtu/yr


Cooling demand

specific:	0.64 kBtu/ft ² yr
target:	3.1 kBtu/ft ² yr
total:	2570.73 kBtu/yr
latent:	0 kBtu/ft ² yr


Heating load

specific:	3.98 Btu/hr ft ²
target:	5.6 Btu/hr ft ²
total:	16035.63 Btu/hr


Cooling load

specific:	1.28 Btu/hr ft ²
target:	4.3 Btu/hr ft ²
total:	5162.04 Btu/hr


Primary energy

specific:	5202 kWh/Person yr
target:	6200 kWh/Person yr
total:	58744.04 kBtu/yr

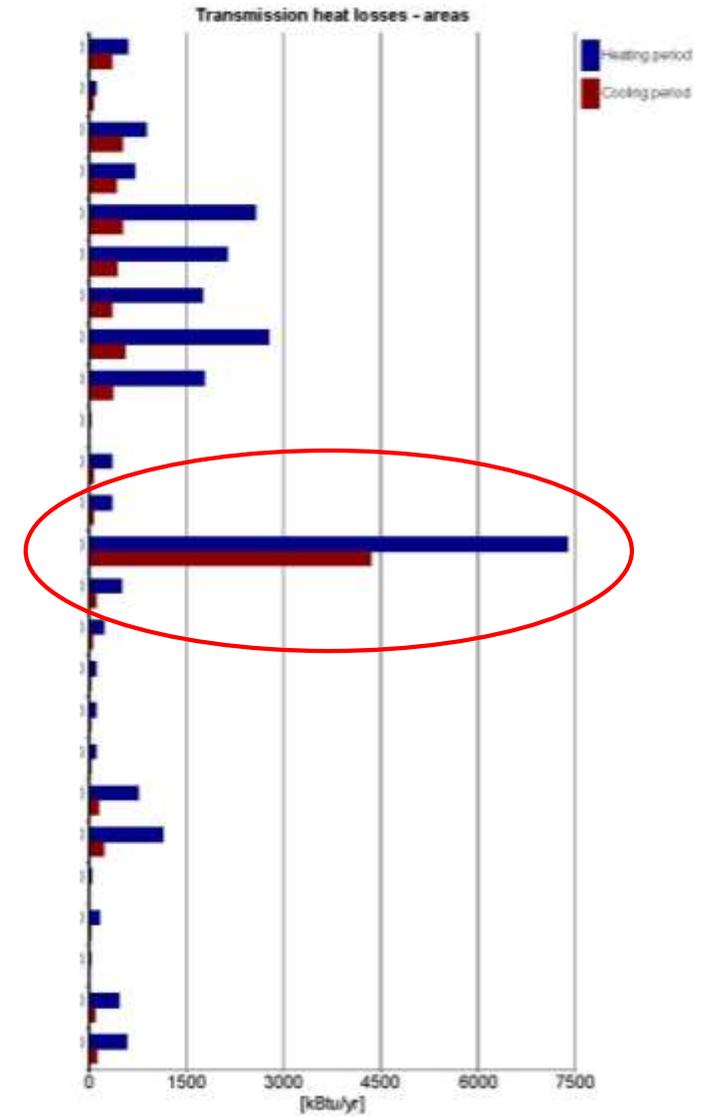

Site energy

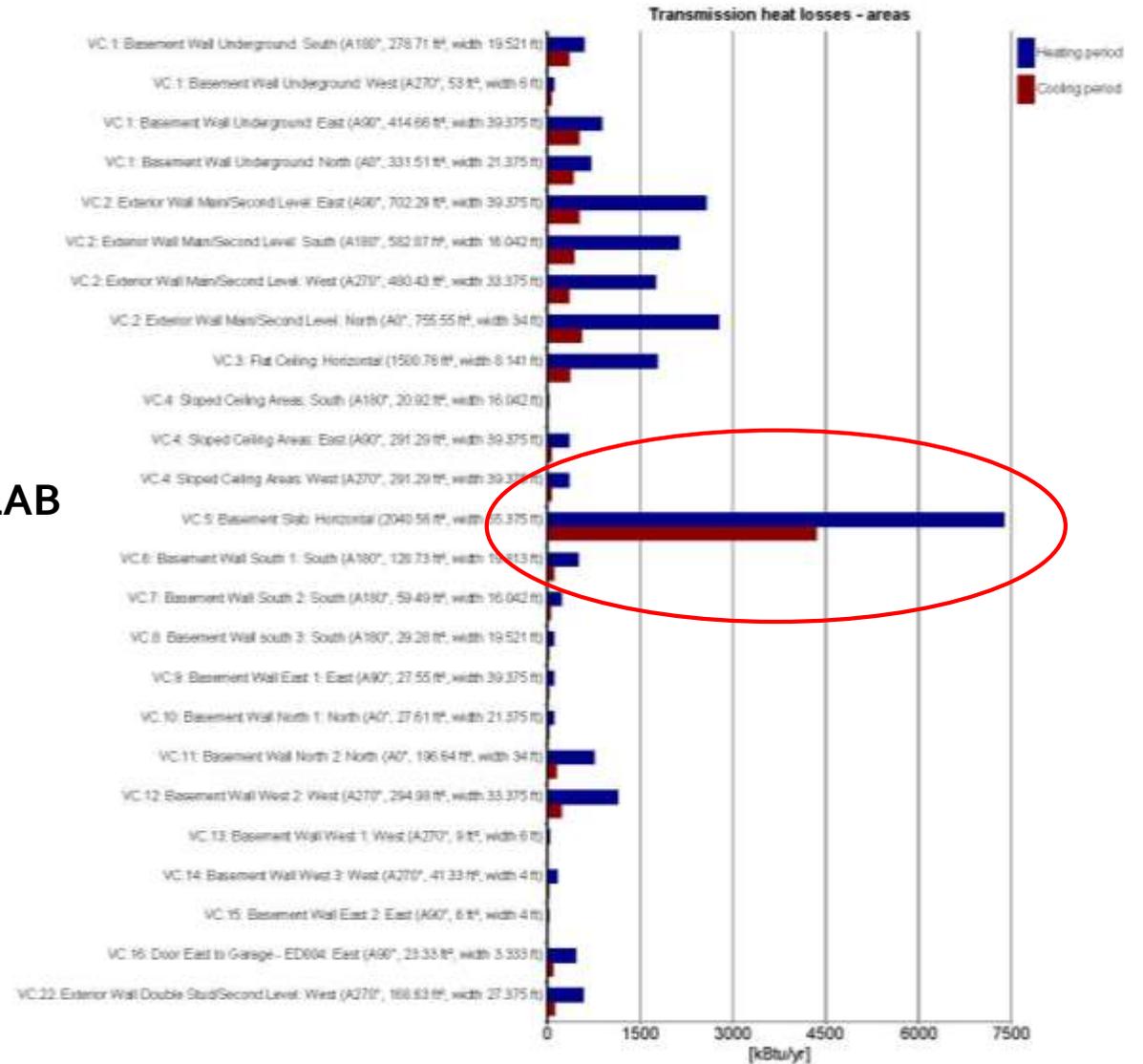
total:	6.18 kBtu/ft ² yr
building systems:	61.98 kBtu/yr
photovoltaic savings:	9.15 kBtu/ft ² yr

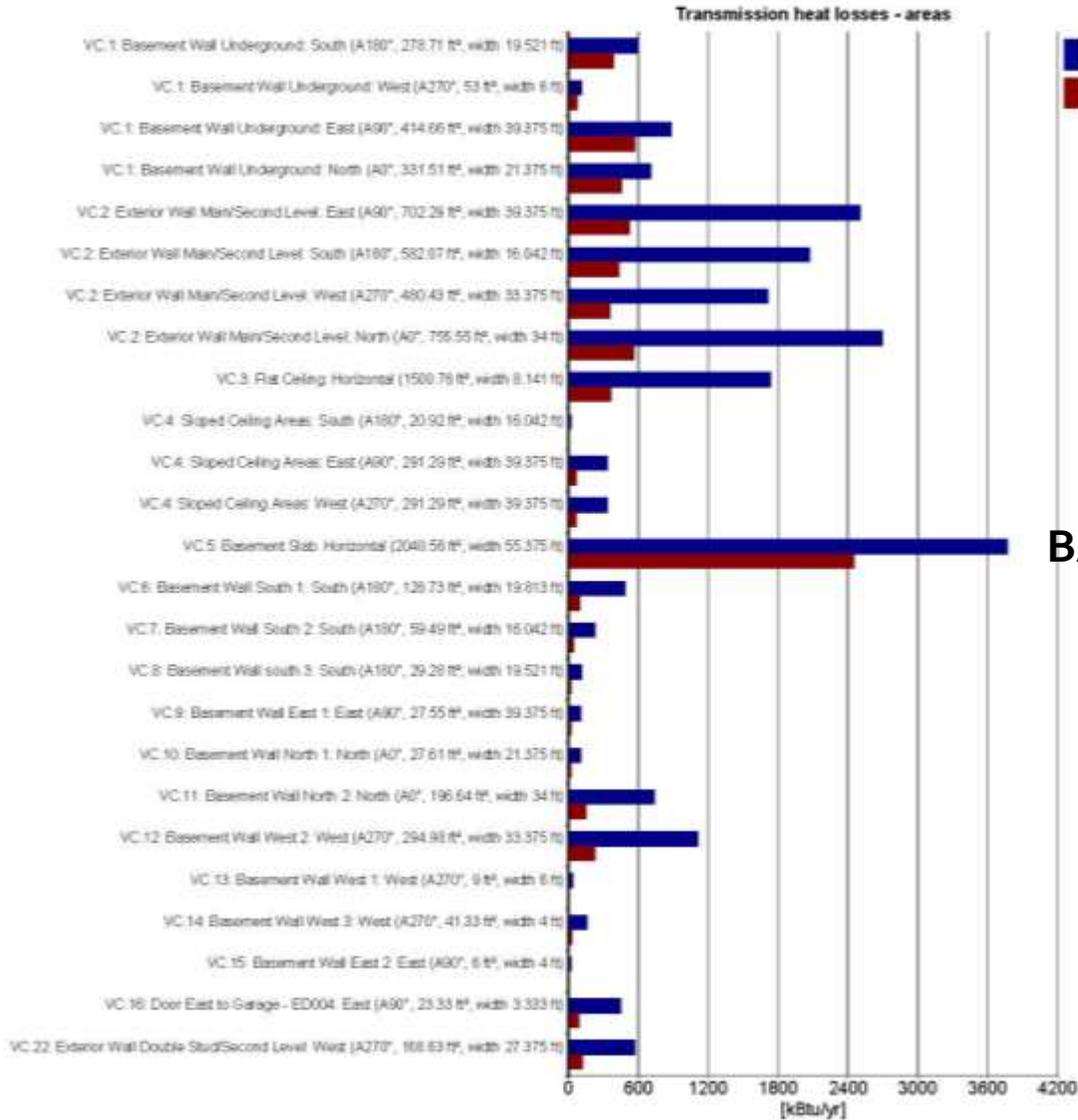

Air tightness

ACH50:	0.42 1/hr
target:	0.81 1/hr
CFM50 per envelope area:	0.03 cfm/ft ²
target:	0.05 cfm/ft ²

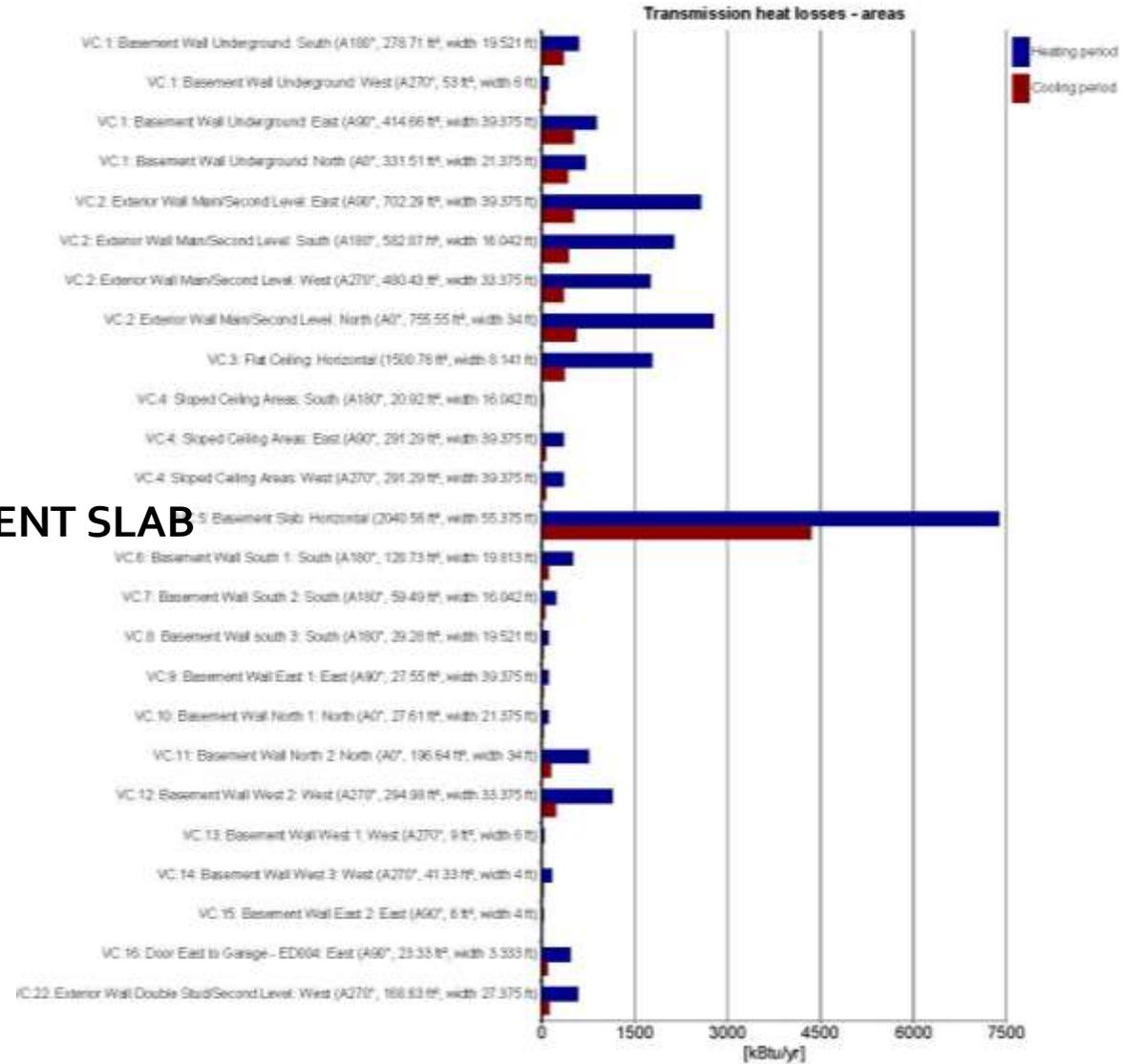




BASEMENT SLAB




BASEMENT SLAB



02

Brief Project Description- Owners Goals



****Energy Efficient Home***

****Healthy Comfortable Indoor Environment***

****Safe Home***

****Durable Low Maintenance Structure***

****Aesthetically Pleasing – Farm House Style***



ICF Home on Mexico Beach Florida That Survived Hurricane Michael in 2018



ICF House That Survived Hurricane Sandy

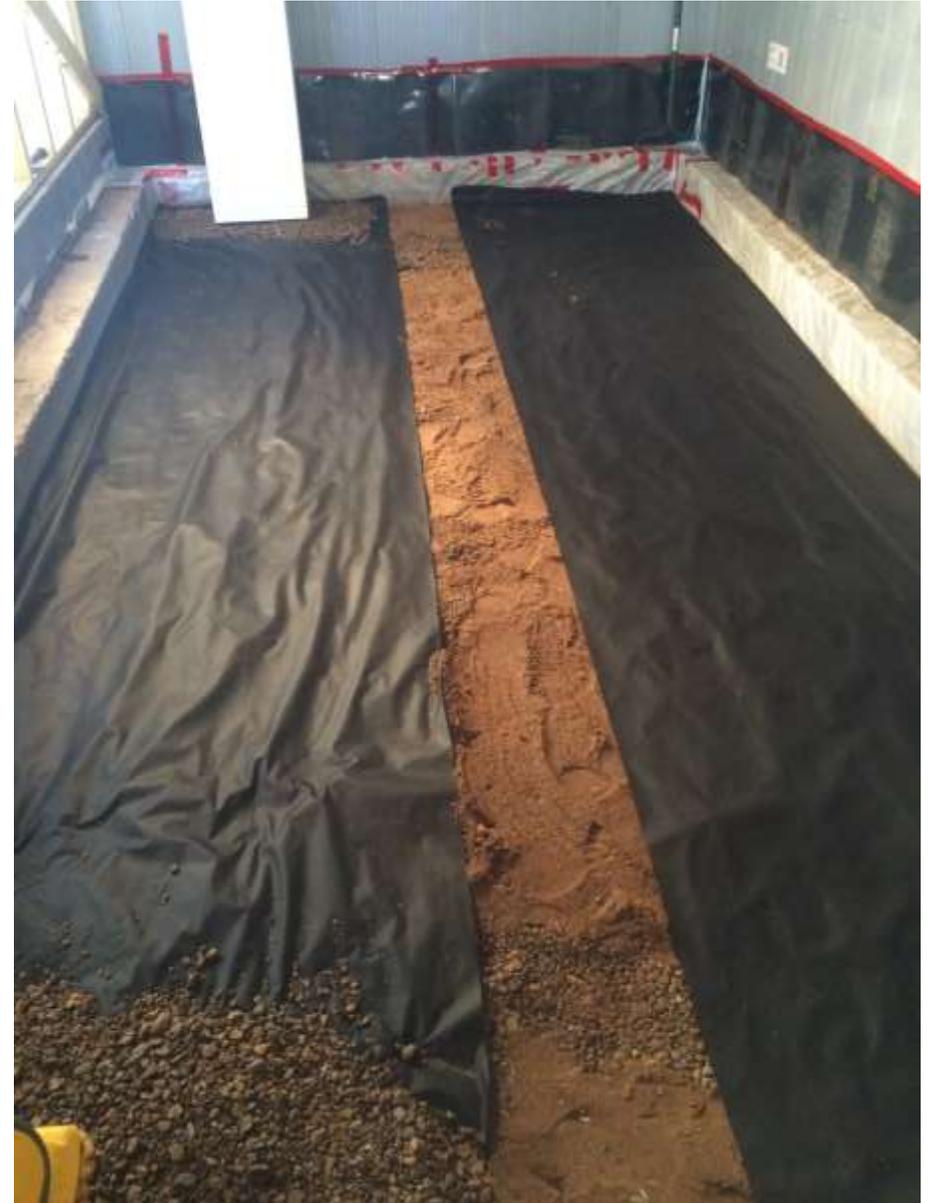


Basement-Plumbing & Backfill





Basement Radon Abatement System



Basement 12" Geofoam

Under
Cement
Slab



Rebar for Basement Slab



3/4" Plywood Roof Sheeting 5/8" Plywood Wall Sheeting

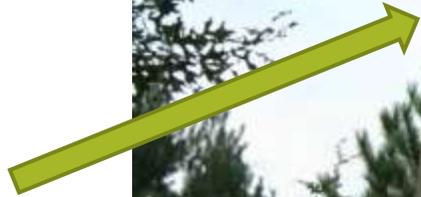


Roof Trusses

August 9, 2016



Energy Heel



Insulating Geof foam



Foam Insulation West Wall Second Floor



2nd Floor-ICF on 3 Sides & Double Stud Wall on the 4th



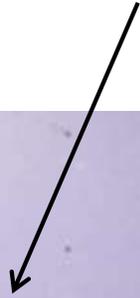
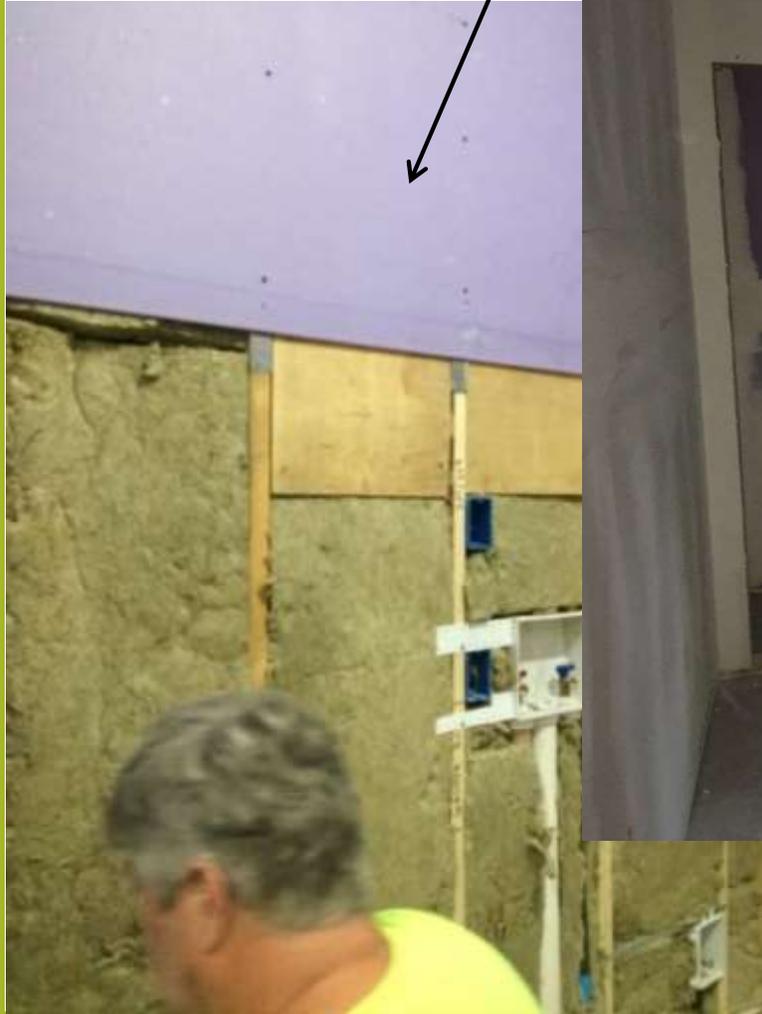
Three Season Porch Challenge



Insulating Both House Attics with 42" AttiCat Fiberglass Insulation



Basement Insulation, Soundproofing & **Backers** **QuietRock** Sheet Rock & **Roxul** Insulation



Henry Blue Skin House Wrap and Window Treatment “The Smurf House”



Triple Pane Fibertec Window U-Factors: 0.19 & 0.15



Window Sills:

Formica product similar to Corian to avoid moisture problems



Passive House Doors by **Doors of Distinction**



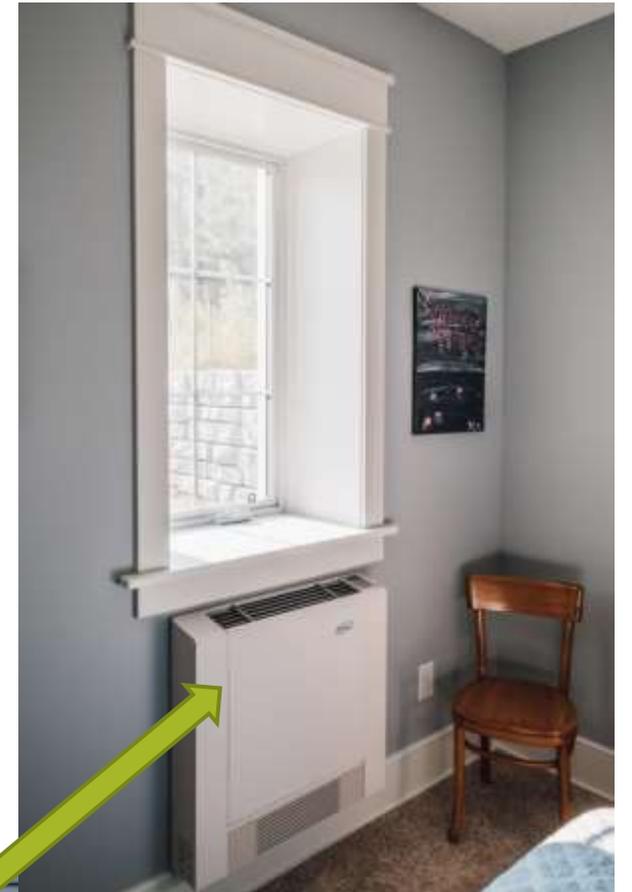
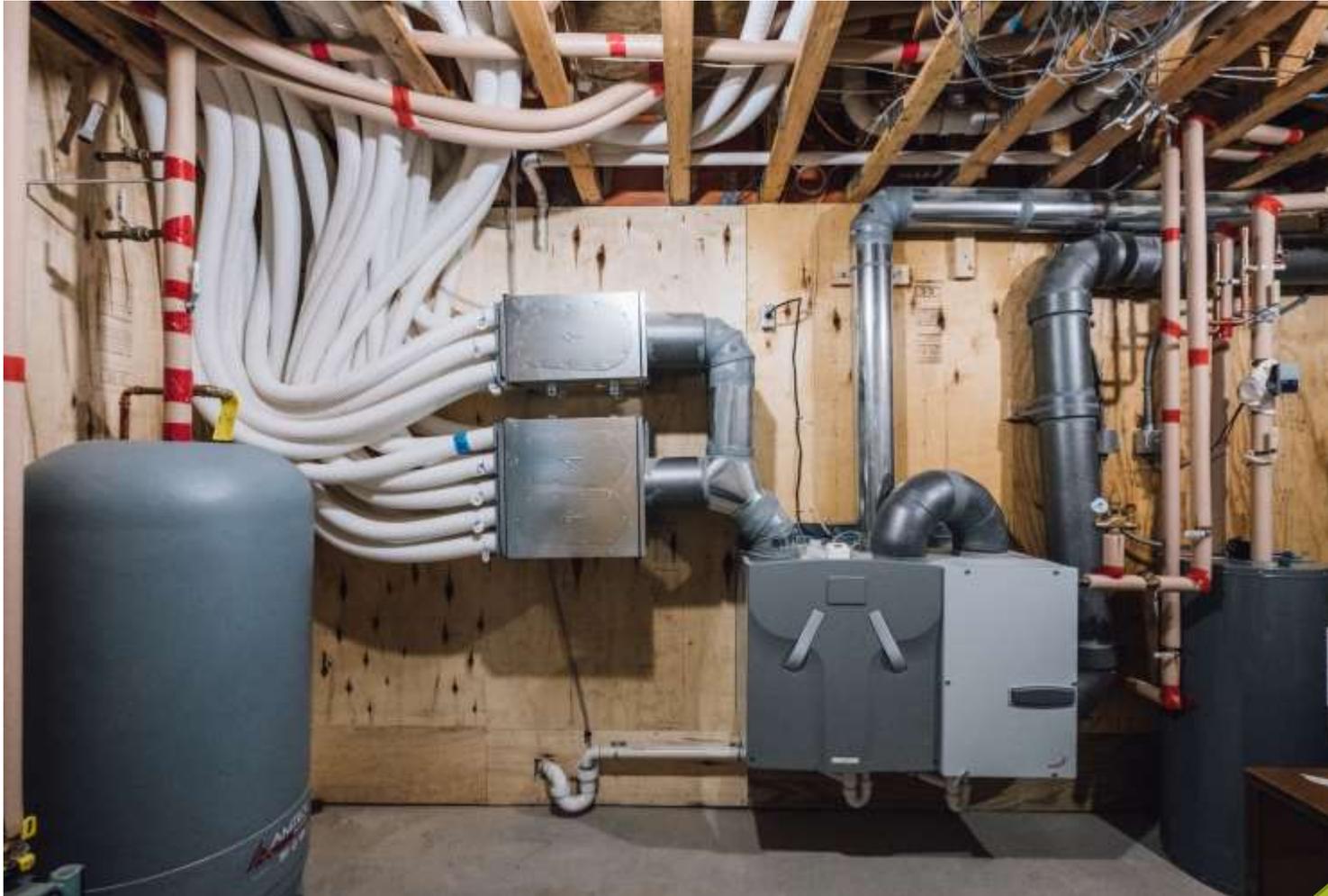
Inside House:

2 X 4's applied flat on main floor outside walls
In the basement they were applied on their side.



Less room on the main floor to run electrical & plumbing on outside walls. We used a hot knife to cut the ICF foam, installed the electrical & plumbing then foamed over it.

Zehnder Air Exchange System



Chiltrix Heating & Air Conditioning System



1-9-18 New Chiltrix Fittings

Charging the Chiltrix Units for Heating/Cooling the House





Zehnder Vents
to be placed
within the
Passive House
Envelope and
not in the ceiling



December 12, 2016



March 28, 2017



October 20, 2017



November 25, 2017



VOC considerations when selecting paints & stains



Dining Room to Living Room VOC Considerations for flooring



Kitchen- VOC Considerations & Range Venting



Lower Level- VOC Considerations for Tile & Carpet



2nd Floor



Clothes Dryer Challenges



Indoor Dryer Vent Pollution

"there are hazardous chemicals coming out of dryer vents."

Environmental Health Perspectives: [Dryer Vents: An overlooked Source of Pollution](#)

Anne Steinemann, Published online Nov. 1, 2011.

Six loads of new pre-rinsed organic cotton towels were washed and dried in residential laundries using no laundry products, then only detergent, then detergent and dryer sheets.

Results: 29 unique VOCs identified in dryer vent emissions

EPA classifies 7 of the VOCs found in dryer vent emissions as hazardous air pollutants

2 samples found acetaldehyde and benzene, known human carcinogens.

August 11, 2018



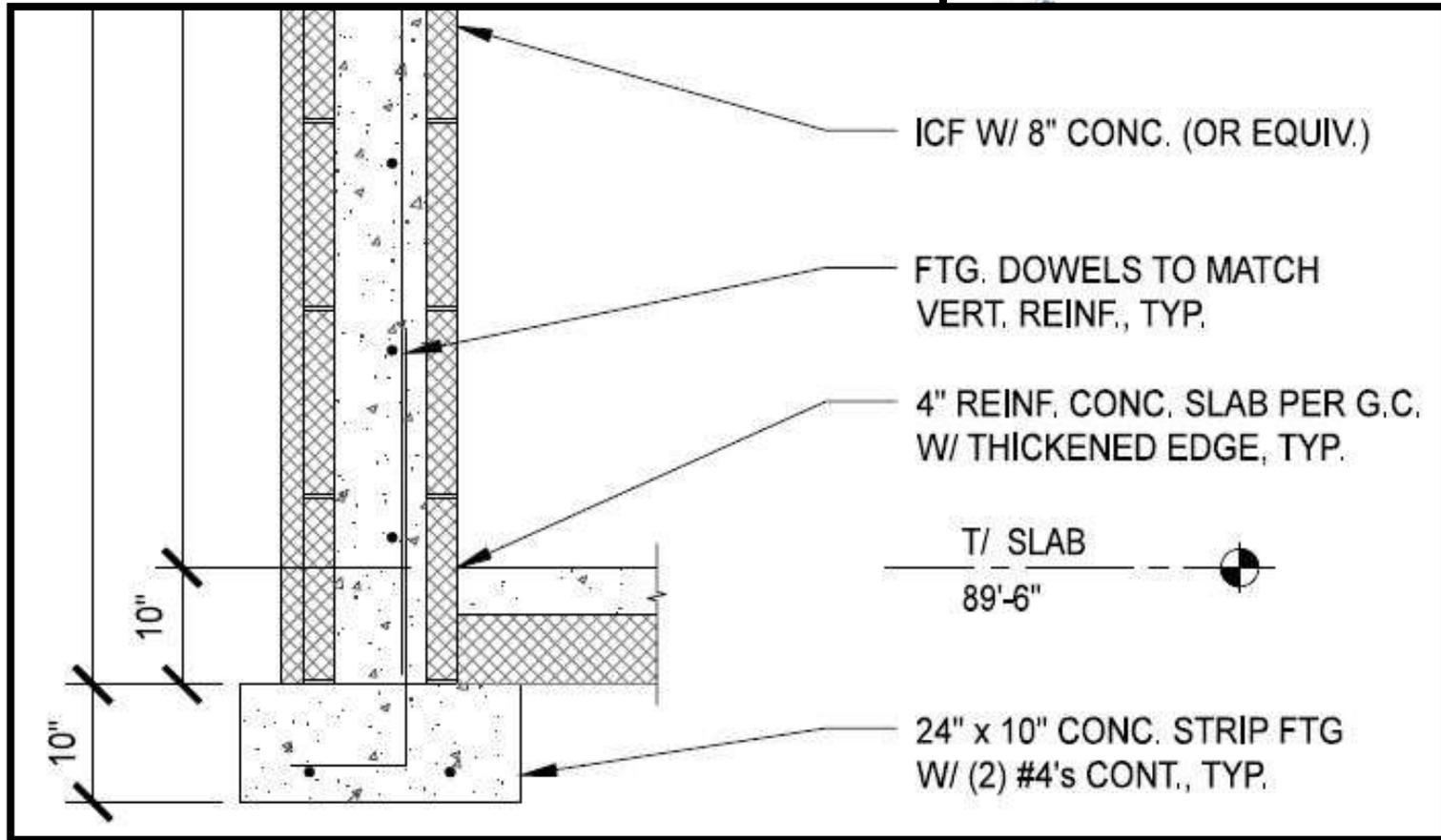


03

Wicking of Moisture through Concrete











WINDOW BUCKS







LOGIX
1.877.843.4463











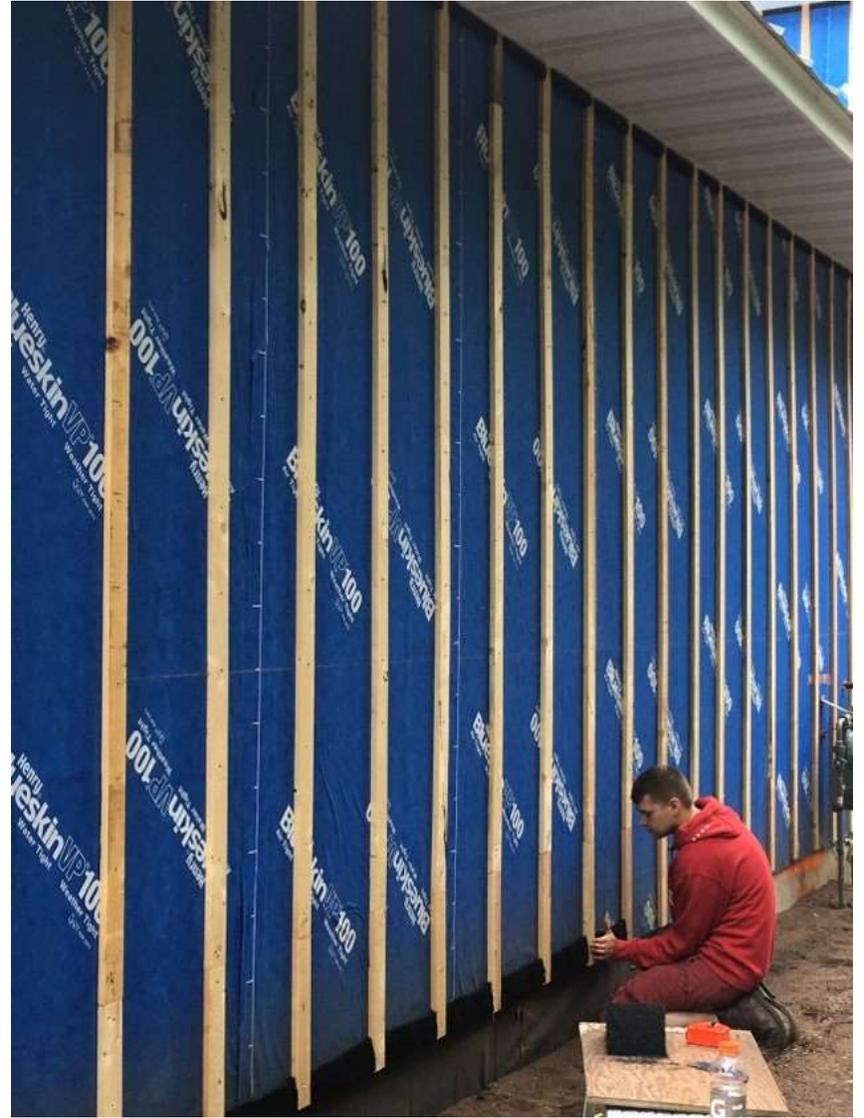












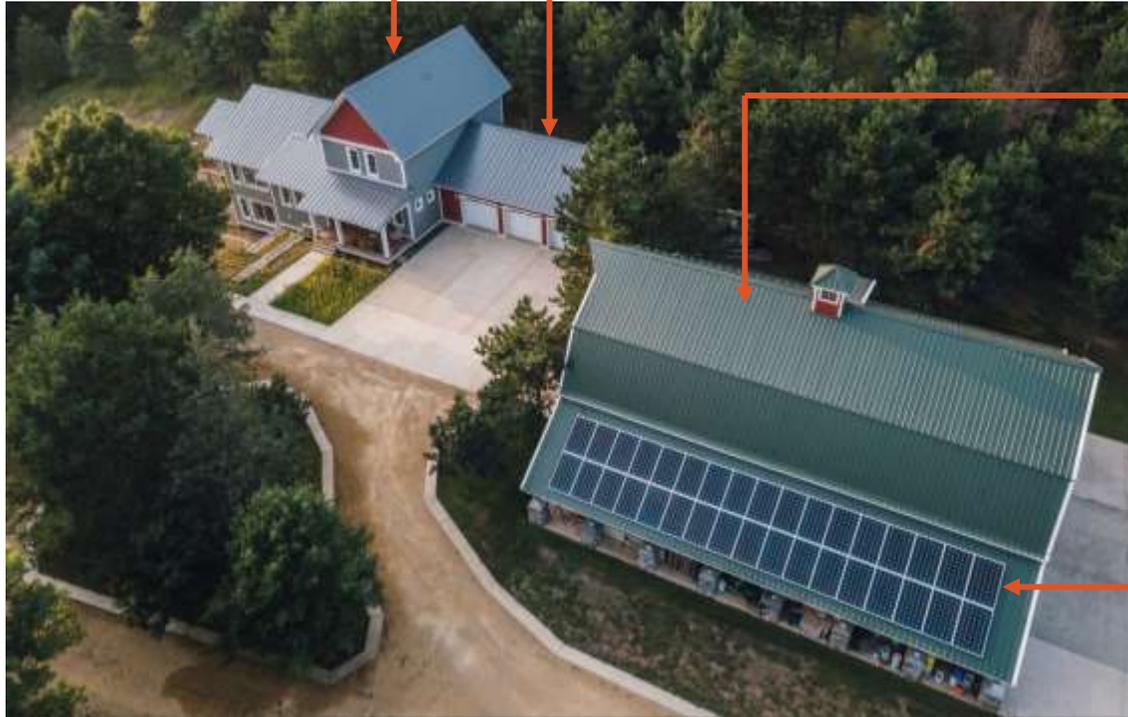
04

Looking at some Final Numbers



Xcel Energy Data

ELECTRICITY USE FOR:



4200 SQ. FT. HOME

1176 SQ. FT. GARAGE

1984 SQ. FT. BARN

9 kW PV SYSTEM

WUFI Targets for Climate Zone 6:

Annual Heating Demand: **6.9 kBtu/ft²yr**

Annual Cooling Demand: **3.1 kBtu/ft²yr**

Peak Heating Load: **5.6 Btu/hr ft²**

Peak Cooling Load: **4.3 Btu/hr ft²**

Primary Energy: **6200 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**



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Primary Energy: **6200 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**

Our Target Goals

Annual Heating Demand: **5.7 kBtu/ft²yr**

Annual Cooling Demand: **0.62 kBtu/ft²yr**

Peak Heating Load: **4.78 Btu/hr ft²**

Peak Cooling Load: **1.3 Btu/hr ft²**

Primary Energy: **5735 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**

4200 SQ. FT. HOME

1176 SQ. FT. GARAGE

1984 SQ. FT. BARN

9 kW PV SYSTEM



RESNET Website (Residential Energy Services Network)

Home Energy Rating System (***HERS***) Index

The U.S. Department of Energy has determined that a typical resale home scores 130 on the HERS Index while a standard new home is awarded a rating of 100.

(HERS) Index: 9

Blower Test 1: **0.66 (at ACH50)**

Blower Test 2: **0.39 (at ACH50)**

Blower Test 3: **0.42 (at ACH50)**



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Peak Cooling Load: **1.3 Btu/hr ft²**

Primary Energy: **5735 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**

After Last Blower Door:

Annual Heating Demand: **4.97 kBtu/ft²yr**

Annual Cooling Demand: **0.64 kBtu/ft²yr**

Peak Heating Load: **3.98 Btu/hr ft²**

Peak Cooling Load: **1.28 Btu/hr ft²**

Primary Energy: **5202 kWh/Person yr**

Air Tightness ACH50: **0.42 1/hr**



Xcel Energy Report for 2018

2018 Electricity Bills

	DATES	KWH-Xcel	KWH-Solar	KWH-Net	COST
JAN	01/01/18 -01/30/18	1512	92	1420	\$206.43
FEB	2/1/18 -2/28/18	1344	287	1057	\$158.38
MAR	03/01/18 -04/01/18	1023	603	420	\$71.96
APR	04/01/18 -04/30/18	717	800	-83	\$6.74
MAY	04/30/18 -05/30/18	244	1004	-760	-\$72.99
JUN	05/30/18 -06/28/18	422	666	-244	-\$13.27
JUL	06/28/18 - 07/30/18	590	872	-282	-\$31.33
AUG	07/30/18 - 08/28/18	545	584	-39	\$12.25
SEP	08/28/18 - 09/27/18	484	693	-209	-\$11.93
OCT	09/27/18 - 10/28/18	766	419	347	\$63.82
NOV	10/28/18 - 11/28/18	1255	159	1096	\$164.30
DEC	11/28/18 - 12/29/18	1607	38	1569	\$230.97
	Yearly Totals:	10509	6217	4292	\$785.33
			Average Monthly:	357.67	\$65.44

WUFI Targets for Climate Zone 6:

Annual Heating Demand: **6.9 kBtu/ft²yr**

Annual Cooling Demand: **3.1 kBtu/ft²yr**

Peak Heating Load: **5.6 Btu/hr ft²**

Peak Cooling Load: **4.3 Btu/hr ft²**

Primary Energy: **6200 kWh/Person yr**

Air Tightness ACH50: **0.81 1/hr**

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Peak Heating Load: **3.98 Btu/hr ft²**

Peak Cooling Load: **1.28 Btu/hr ft²**

Primary Energy: **5202 kWh/Person yr**

Air Tightness ACH50: **0.42 1/hr**



with solar panels

Primary Energy: **4292 kWh/yr**

Primary Energy: **2146 kWh/Person yr**

without solar panels

Primary Energy: **10,509 kWh/yr**

Primary Energy: **5254 kWh/Person yr**

New Homes

Let's start with the easy one: new construction. The rule here is that a house can never be too tight. The Passive House program takes houses about as far as you can go with air tightness, and their threshold is 0.6 ACH50. I tested a net zero house a couple of weeks ago that was at about 0.5 ACH50. That's really tight!

A target that's more achievable for anyone - and which the 2012 **International Energy Conservation Code (IECC) will require for most climate zones - is 3 ACH50**. That's also the level that Joe Lstiburek identified as a good target in his great article on Blower Door testing new homes, *Just Right and Airtight*.

(Energyvanguard.com, 2018)



THANK YOU!